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Detection of Covid-19 from Chest X-Rays usingImprovised Convolutional Neural Network Model

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Abstract. The COVID-19 pandemic, caused by the rapid global spread of the coronavirus disease 2019, has had a significant impact, affecting millions of individuals. In order to effectively combat the transmission of COVID-19, early identification is crucial. To address this, a proposed model called CovidDetectorhas been created, utilizing a Convolutional Neural Network (CNN) to automatically screen chest X-ray images for COVID-19.The CovidDetector model comprises three convolutional layers with increasing filter numbers, followed by max-pooling layers and two fully connected layers. This model has been trained and tested on a dataset containing three categories: Covid-19, Normal,and Viral. By analyzing chest X-ray images, it can determine whether Covid-19, Normal, or Viral patterns are present. The evaluation metrics, including F1 score: 96.7, precision, and recall,all yielded a high accuracy of 95% when compared to LSTM (Acc:83%, F1-Score: 84.22), RNN (Acc: 87.19%, F1-Score: 89.05), MLP (Acc: 88.22%, F1-Score 92.37). Its potential application ina clinical setting can assist in early virus detection, ultimately leading to lives being saved. As AI technologies continue to advance and improve, the CovidDetector model exemplifies the effectiveness of deep learning techniques in the battle against COVID-19.

Keywords: *COVID-19, CovidDetector, X-ray, ConvolutionalNeural Network and Deep learning*

1 INTRODUCTION

The main cause of the ongoing pneumonia that began in December 2019 is the new coronavirus. Initially named COVID-19 (Corona Virus December 2019) and commonly referred to as COVID-19, this disease has introduced more competition. When it comes to human health, diagnosing COVID-19 is more challenging compared to other illnesses. In comparison to individuals affected by COVID-19, those with pneumonia experience more significant respiratory issues and spread the virus more rapidly [1] [2] [3]. Approximately 82% ofpatients with this disease show no symptoms or experience mild effects, while affected patients suffer severe injuries.Analysis of infected cases reveals a mortality rate of 5% and a 95% chance of recovery. Despite global preventive measures, the epidemic is rapidly spreading. Given that itposes the world's biggest challenge, researchers from various fields have embarked on efforts to solve this problem. One such problem is self-diagnosis, as the current test for detectingpositive cases of COVID-19 relies solely on a time-consumingprocess called reverse transcription-polymerase chain reaction(RT-PCR), which is prone to false positives[4].

Therefore, itis crucial to develop more accurate and faster methods for disease detection in patients. X-ray images and Computed Tomography (CT) scans offer easier means of diagnosing diseases in patients [5]. Even when an infected person does notexhibit symptoms like cold, fever, or cough, imaging can aid indiagnosing the disease. With the main effects of the COVID-19virus occurring in the lungs accompanied by fever, researchershave started focusing on chest X-ray imaging for early detection of infection. Chest X-rays have generated substantial data on COVID-19 and are instrumental in developing new machine learning algorithms, a type of artificial intelligence

(AI). Researchers have shown a keen interest in employing AIand computer-based identification to confidently detect cases of COVID-19.

Recently, AI-based tools such as X-ray images and CT scans have been proposed in various studies, especially in the field of medicine. Deep learning, a powerful tool for understanding cognitive problems, plays a significant role in image classification tasks and is applied in different ways [6]. The proposed work the CovidDetector model, which is a deep learning system based on convolutional neural network (CNN)architecture. It effectively detects the COVID-19 virus from chest X-ray images for rapid diagnosis. In summary, deep learning and image processing are two important technologies utilized in the realm of artificial intelligence. Deep learning aids in pattern recognition within data and finds applicationsin computer vision, natural language processing, and other fields[7][8][9]. Image processing refers to the extraction of valuable information from digital images using algorithms thatidentify patterns and features [10].

It enables object recognition, size and shape measurement, and even image quality assessment. Deep learning, as a subset of machine learning, has witnessed remarkable growth over the past decade. It employs deep neural networks (DNNs) to recognize patterns indata, where nodes within the network perform specific tasks. In image processing, deep learning is used to detect objects, identify edges, segment images, classify images, and facilitate more accurate and efficient image algorithms. Deep learning and the digital age are intertwined, resulting in an explosionof diverse information from around the world. Termed big data, this vast amount of data originates from sources like social media, internet research, e-commerce platforms, and online streaming. While this data is easily accessible and shareable through technologies like cloud computing, it often contains insignificant information that takes years for peopleto comprehend and provide relevant insights.

2 LITERATURE SURVEY

The study is to develop a deep-learning pipeline for diagnosing and discriminating between viral, non-viral, and COVID-19 pneumonia using chest X-ray [11] images. The article mentions the use of a deep-learning pipeline, but it does not provide specific details about the architecture or parameters ofthe model used. It would be helpful to have more information about the specific deep-learning techniques employed, such as the types of neural networks used (e.g., convolutional neural networks), the number of layers, and any additional pre-processing or post-processing steps applied to the images.

The objective of the article is to describe the contributionsof the Bio banking and Biomolecular resources Research Infrastructure-European Research Infrastructure Consortium (BBMRI-ERIC) [12] to research and knowledge exchangeon COVID-19. It does not describe any specific research studies or experiments conducted by BBMRI-ERIC. It would be beneficial to have more information about the methodsused to contribute to COVID-19 research and knowledge exchange, such as collaborations, data sharing initiatives, or specific projects undertaken. The objective of the article isto identify common pitfalls in using machine learning for the detection and prognosis of COVID-19 using chest radiographsand CT scans, as well as to provide recommendations to overcome these challenges [13]. The methodology used for identifying the pitfalls and formulating recommendations isnot explicitly described. The article should provide details about the methodology employed for federated learning in thisstudy. It should describe the specific federated learning algorithms or frameworks used, along with any modifications or adaptations made for the prediction of clinical [14] outcomes.

The objective of the article is to develop a computer-aided detection (CAD) system for COVID-19 using chest X-ray imagesand a [15] Convolutional Neural Network (CNN) model. It should describe the specific CNN architecture used, including the number of layers, filter sizes, and activation functions. Additionally, it should explain the data collection process,including the number of samples and their characteristics. The article's title suggests that it focuses on characterization approaches for analyzing COVID-19 pneumonia lung imaging.However, it is important for the article to clearly define the specific aspects of characterization [16] covered and providea comprehensive overview of the relevant literature and techniques in this area. Additionally, the article should address thelimitations and challenges associated with using AI for lung image characterization. The article should describe the specificangle transformation technique employed and explain how it isintegrated with the GoogleNet and LSTM [17] models.

Information about the architecture, hyper parameters, and training process of these models would be valuable. It should describe the specific transfer learning techniques employed, such as thepre-trained models used and the approach [18] for fine-tuning.Information about the network architecture, hyper parameters, and training process would be valuable. The common metrics for binary classification tasks, such as COVID-19 detection, include accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve (AUC-ROC). Report-ingthese metrics is crucial for understanding the effectiveness of the proposed approach. the methodology used for comparing the classification models. It should describe the specific deep learning models employed, including their architectures, hyperparameters, and training processes. Information about the data preprocessing steps [19] and any additional techniques used for model training or evaluation would be valuable. It should describe the specific ensemble learning techniques employed, such as the types of base classifiers [20] used and the approach for combining their predictions. Information about the ensemble learning strategy, hyper parameters, and training process would be valuable.

3 METHODOLOGY

3.1 Convolutional Neural Network

Convolutional Neural Networks are a subclass of deep neural networks used extensively to analyze visual pictures. They are capable of recognizing and categorizing distinctive characteristics from images. Its applications include picture and video recognition, classification of images, image analysisfor medical purposes, computer vision, and word processing. Make a third process to illustrate how one task changes the appearance of another by creating a third process. In simple terms, two pictures that can be described as a matrix maybe split by to get results for extracting visual characteristics.A convolutional device that uses the approach of feature extraction to dis-tinguish and evaluate various aspects of the picture for analysis. A fully connected layer that makes useof the convolutional output of the processing object and infers from the picture the category of the features that were retrievedin the previous phase. The CNN's layers are broken downinto three categories: layer, layered layer, and fully connected (FC) layer. CNN architecture is produced by combining these procedures.

3.2 Layers of Convolutional Neural Network

Convolutional Layer: A "filter" analyzes the picture numerous times, creating a unique map to determine which class each feature belongs to.

Pooling layers: (down sampling): This technique reduces the quantity of data in each feature acquired from the convolution layer while keeping the most crucial data.

Fully connected input layer (flatten): This phase takes the output of the preceding operation "flattens" it, and then transforms it to a vector that may be used as input to the following step.

In the first layer, which is completely linked, the right label is predicted using Analysis-related inputs and weights.

Fully linked output layer: It returns the final probability for each label.

The foundation of the CNN architecture is convolutional layers, which perform feature extraction and often com-bine both nonlinear and linear operations with operations involving convolution and activation functions. A tiny string of integers (referred to as a kernel) is used as the input for the specific kind of linear operation known as convolution, which is utilized for subtraction. Tensors are used in math. The feature map is obtained by calculating the smart result that exists between every single point of the kernel and each position of the input tensor, then adding it to the final value that represents the associated point of the output tensor. This technique makes use of numerous kernels to create a feature map that depicts various input tensor qualities, allowing distinct cores to be represented by various end results. The size and number of cores are the two primary hyper parameters that define the convolution function. The first is often 33, although occasionally it's 55 or 77. The latter, which is optional, determines the output feature map's depth. The position of each kernel is restricted in the convolution procedure depicted above from overlapping with the external tensor input components, and the output feature map's height and breadth are less than those of the input tensor. This issue can be resolved by padding, often zero padding, which adds zero rows and rows to each edge of the tensor object and the outer edge to maintain consistency throughout the convolution to fit the core. The operation's general architecture has been provided in order to help you better understand how CNN operates Fig. 1.

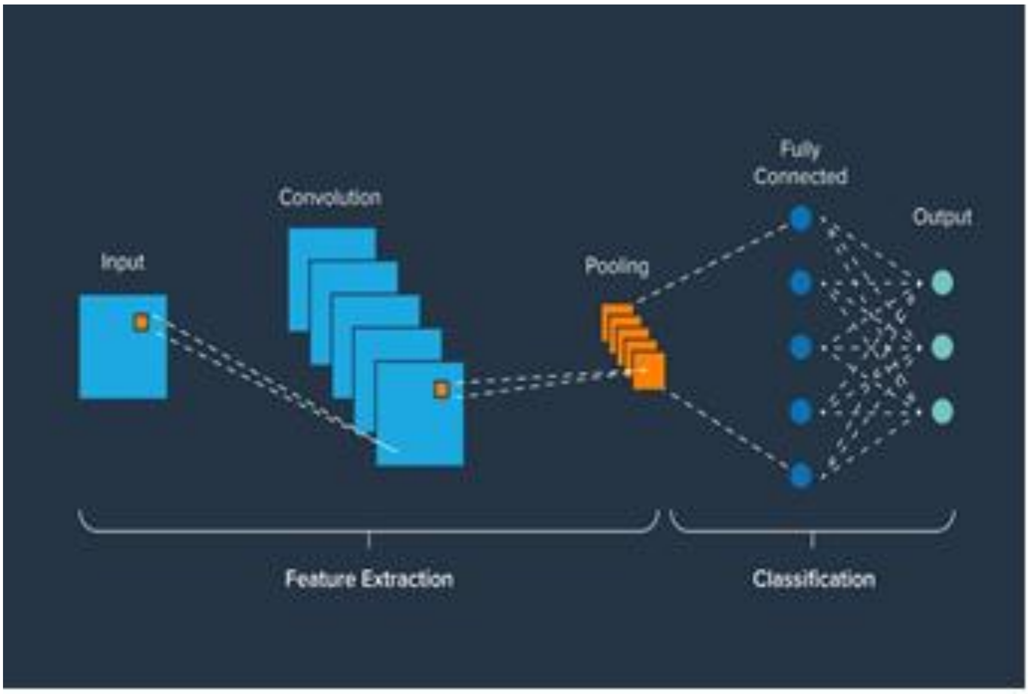

Fig. 1.The general architecture of CNN

- Modern CNN designs frequently employ numerous layers and zero padding to retain in-plane dimensions. The convolution operation's shared weight generates the following characteristics:
- Because the kernel traverses the full picture position and the local model detection research, the local model b that was derived from the translation is made invariant.
- Operational attributes-The field of vision was captured using a spatial hierarchy model, large-scale subsampling,and pooling.
- Reducing the amount of unlearned in relation to the total neural network model efficiency improves these characteristics.

The most appropriate kernel for processing is chosen during the training phase of a CNN model using a convolutional technique, will be detailed later. Kernel size, kernel count, padding, and step are hyperparameters that need to be set before training the kernel is the same as what was learned during convolutional layer training. In addition to these three sets, the following ReLU (Rectified Linear Unit) Activation function is also significant: ReLU option is used to choose the neural network's output, such as yes or no. Values can be modified and it ranges from 0 to 1, or -1 to 1, etc. (Relativefunction). Because it is straightforward and computationally efficient, ReLU (Rectified Linear Unit) is a popular activation function in deep neural networks. In other words, x is the function's input, and f(x) = max (0, x). In cases where the input is positive, the function returns the value; in cases where the input is negative, it returns 0. The piecewise linear nature of the function makes it simple to incorporate nonlinearities in the network.

Compared to other functions like the sigmoid or the tanh, ReLU offers numerous benefits. First, it solely impacts the initial entry threshold, which is why it is important. The second benefit is that it permits gradients to flow freely duringrecovery, assisting in preventing the extinction problem that arises in deep neural networks when gradients are too tiny. Third, it has been demonstrated that deep neural networks perform better at a number of tasks, including speech recognition, object identification, and picture categorization. ReLU does, however, have some restrictions. The "dead ReLU" problem, where certain neurons remain at 0 throughout trainingand are not triggered again, is one of the key issues. This results in a loss of representation in the network. Use of an alternative ReLU, such as the Leaky ReLU, which addsa tiny region to the negative space to enable some data topass, can alleviate this problem. ReLU's lack of smoothnessis another drawback, which makes it challenging for some optimization techniques that rely on gradual gradients. ReLU is a widely used application in deep neural networks becauseit is straightforward, inclusive, and effective for a variety of applications. It's crucial to understand its limitations and to take into account alternatives when necessary.

3.3 CovidDetector a custom CNN model

The CovidDetector model, which makes use of the PyTorch package is a convolutional neural network. Depending onwhether the input snapshots include COVID-19, viral pneumonia, or otherwise normal, the model is intended to divide them into three groups. The schematic representation of new CovidDetector Algorithm is shown in Fig. 2. Multiple layers make up the CovidDetector model, which transforms the incoming picture data through a sequence of procedures to provide a prediction. The model specifically has the followinglayers: Each of the three convolutional layers (conv1, conv2, and conv3) has 64, 16, and 32 output channels. To extract information pertinent to the classification job from the input image, each convolutional layer applies a series of filters. A max-pooling layer (pool) reduces the feature maps' spatial dimensions by down sampling the output of the convolutional layers. Two fully connected (or linear) layers classify the feature maps produced by the convolutional layers (fc1, fc2). The final layer contains 3 output units, which correspond tothe three categorization groups, whereas the first completely linked layer has 512 output units. Except for the final output layer, each convolutional and fully linked layer is followedby a rectified linear unit (ReLU) activation function. Making complicated judgments based on input data requires non- linearity, which the ReLU function helps to add into the model. The input picture data is successively processed througheach layer of the model in the forward technique. Up until the final output is generated, each layer's output is fed intothe subsequent layer. The model then generates a vector of probabilities showing the chance that each of the threecategories corresponds to the input image.

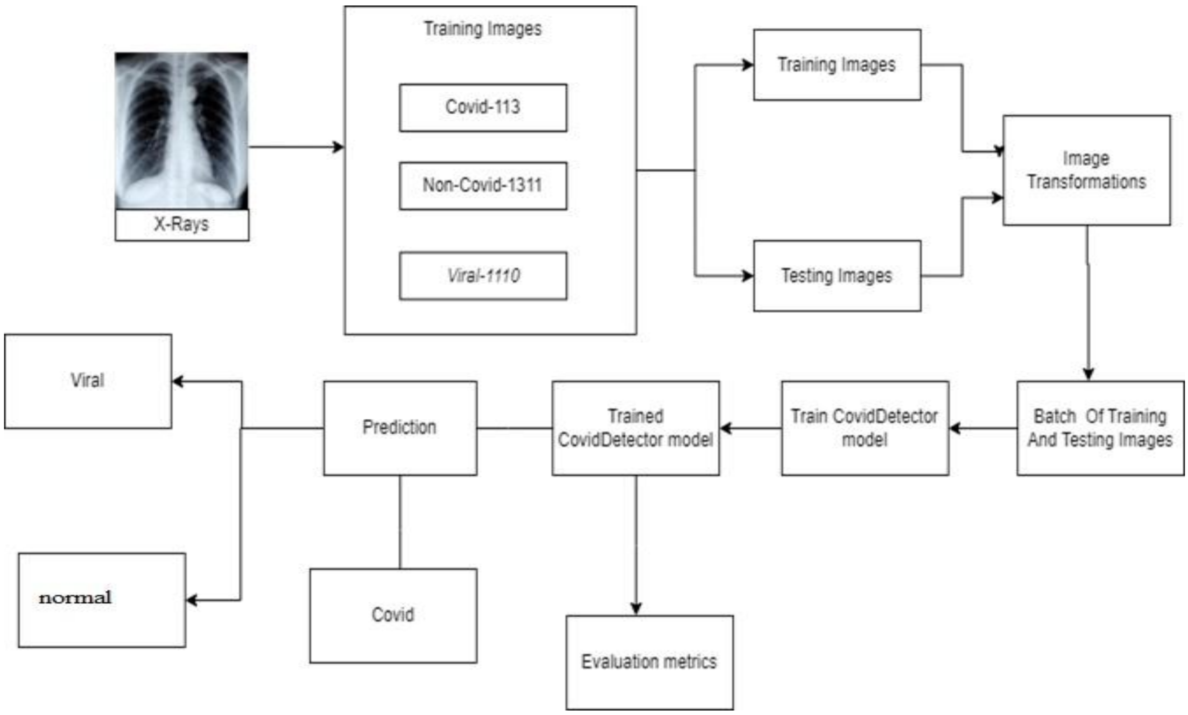

Fig. 2. Schematic Representation of New CovidDetector Algorithm

4 RESULTS & DISCUSSIONS

The proposed CovidDetector model using CNN obtainedbetter performance metrics when compared to the existing methodologies. The performance metrics including accuracy, precision, recall, and F1 score had been calculated for the proposed model. These metrics were compared with the performance of existing methodologies including Long Short Term Memory Networks (LSTM), Recurrent Neural Networks(RNN), and Multilayer Perceptron's (MLP) where the proposedmodel using CNN had achieved the highest performance when compared to the other existing models. The results obtained by the proposed and the existing models were given in Table 1. From Table 1, it can be noted that the proposed CovidDetector Model that uses CNN for prediction gained the highest performance in terms of accuracy, precision, recall, and F1 score. The graphical representation of the performance comparison is given in Fig. 3.

Table 1. PERFORMANCE COMPARISON OF THE PROPOSED AND EXISTING MODELS

Model	Acc	Pre	Recall	F1 Score
LSTM	83.25	83.09	84.66	84.22
RNN	87.19	87.02	89.12	89.05
MLP	88.22	88.14	91.77	92.37
CovidDetector	95.36	95.24	96.34	96.71

Fig. 3. Graphical Representation of Performance Comparison

Three alternative labels were trained using the dataset, which had approximately 14000 images. From the results obtained, it is evitable that the proposed CovidDetector model had increased in accuracy by 7.14%, precision by 7.1%, recall by 4.57%, and F1 Score by 4.34% when compared tothe traditional Multilayer Perceptron Classification. Thus the proposed model had increased the overall prediction rate of x ray image-based covid detection at its earlier stages. This hasbeen explained in more detail in Fig. 4.

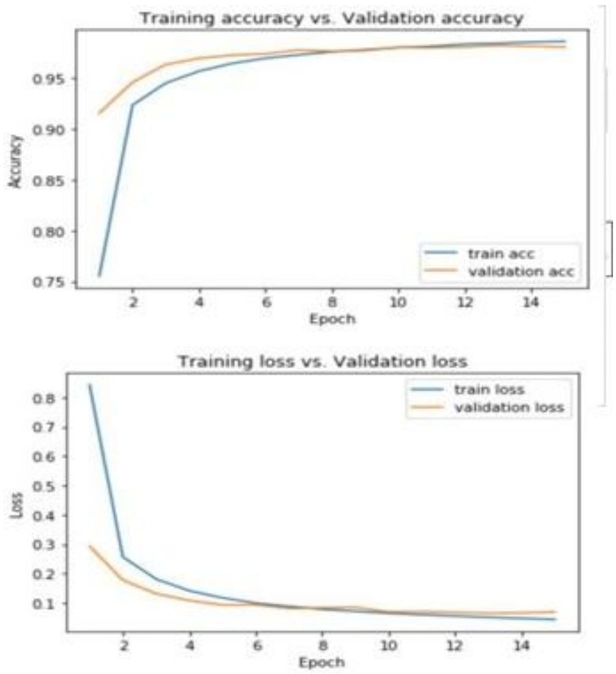

Fig. 4. CovidDetector model accuracy and loss graph

5 CONCLUSION

We draw a conclusion from this by saying that the Covid- Detector model shows hope for the critical need for speedyand reliable COVID-19 identification. It has been proven that the CNN (Convolutional NN) model is reliable for spotting Covid-19 patterns in rib cage X-ray pictures. In the clinical environment, it may be applied to help in early illness detection and prevention, eventually saving lives. A further indication that the model will be helpful in urgent circumstances like emergency services and emergencies is its capacity to handle unseen data. When compared to LSTM (Acc: 83%, F1-Score: 84.22), RNN (Acc: 87.19%, F1-Score: 89.05), and MLP(Acc: 88.22%, F1-Score: 92.37), the suggested Covid Detector's performance metrics, including F1 score: 96.7, precision, and recall, all produced a high accuracy of 95Future enhancementsto the model might increase its precision and usability by including more diagnoses using a mobile phone, which can eventually improve global efforts to tackle the disease. The CovidDetector model, which uses deep learning to combat COVID-19, has the potential to completely alter how we approach illness detection and management. To increase the model's usability and accessibility in the future, hardware integration or the development of mobile applications may be used. The development of an intuitive mobile app might enable patients and physicians to quickly and easily screen for COVID19 utilizing the more specialized chest X-rays that are only usable in a few locations. Additionally, mounting the CovidDetector model on medical apparatus like portable X- ray units or diagnostic tools can increase their use and enable COVID19 quick response analysis in a variety of settings.As a result, the screening procedure will be more effectiveand accurate, which will help with illness detection and early diagnosis in the long run. Further work on enhancing the data used to train the model, integrating data from other sources, and incorporating new diagnostic approaches may further help to improve CovidDetector's accuracy and resilience in the future. By making adjustments to the algorithm, more individuals could potentially be rescued promptly and with the necessary care, perhaps improving accuracy.

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